Leading the 5G IoT Race: Key Industry Insights Series 5. 5G RedCap

By **Robin Duke-Woolley**, CEO, Beecham Research

3GPP has introduced three primary use cases for 5G New Radio (NR) – enhanced Mobile Broadband (eMBB), massive Machine Type Communications (mMTC), and ultra Reliable Low Latency Communications (uRLLC). But what if your IoT application doesn't really fit one of these primary cases – it actually needs a bit of each? That's where 5G RedCap (Reduced Capability) comes in – and it looks set for stardom.

1. What's so special about 5G RedCap?

Firstly, what's so special about 5G New Radio (NR) as far as IoT is concerned? Essentially, 5G NR was designed as a completely new air interface in order to support the wide variety of services, devices and deployments envisaged for 5G, and across a diverse spectrum. It also needed to be backwards and forwards compatible. In other words, it has been designed as much for IoT devices as for mobile handsets.

This is a far cry from earlier generations, where IoT and M2M (machine-to-machine) before it essentially had to look a bit more like mobile handsets, which added cost and complexity. Yet there are many IoT applications where each of the three primary use cases for 5G NR are an overkill in one way or another. 5G Redcap – also known as NR light (or lite) – provides the answer for this. There are also two of them on the way: RedCap Release 17 (R17) and RedCap Release 18 (R18).

Reduced Capability of 5G: offering additional capabilities compared to LTE

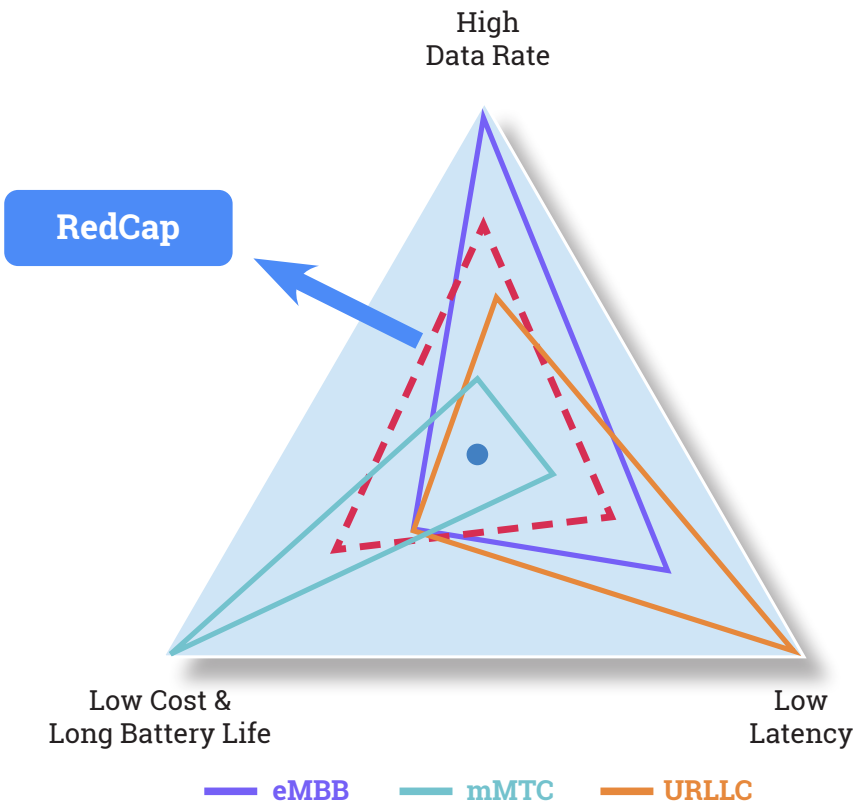


Figure 1: RedCap is in an IoT sweet spot

To get an idea of the significance of these, **Figure 2** below shows how these RedCaps compare with their equivalent LTE Categories – in particular Cat 1 and Cat 4.

So what does RedCap actually offer? **Figure 3** gives a quick guide. Essentially, those applications that require low latency and high reliability, but less bandwidth than eMBB and low power consumption.

This makes RedCap ideal for a wide range of applications – including smart grids, livestreaming, industrial automation and smart wearables. Fast data and power efficiency – a welcome addition to the IoT connectivity landscape.

Segment of RedCap within cellular devices

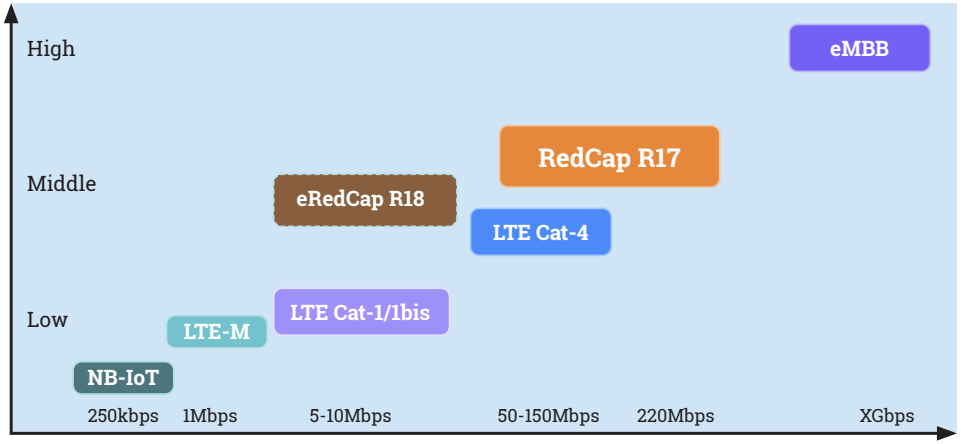


Figure 2: RedCaps R17 and R18 compared with LTE Cats 1 and 4

RedCap (Reduced Capability) = NR light (NR lite)

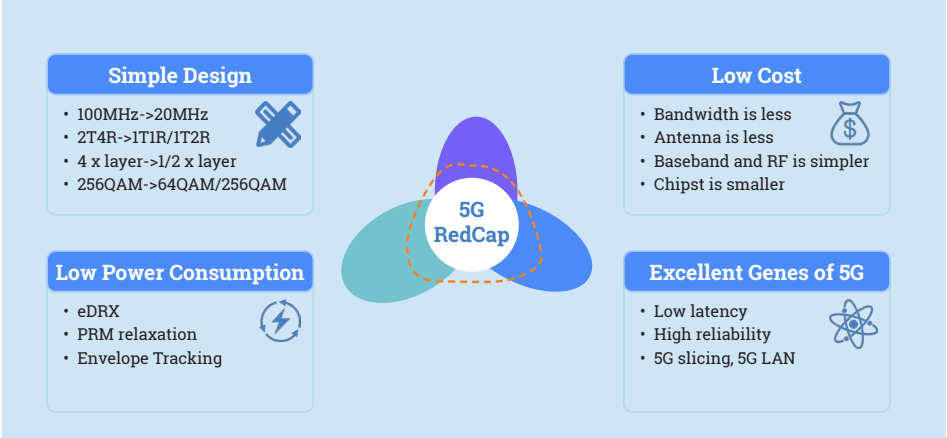


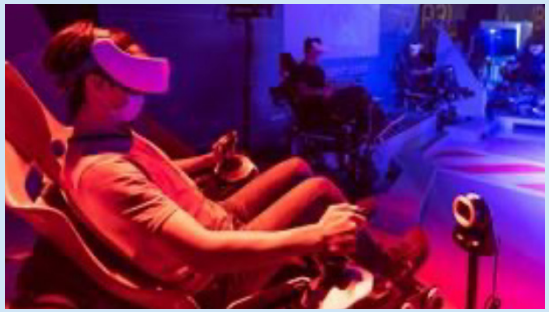
Figure 3: RedCap 'joins the dots' in IoT within the 5G landscape

2. Where will RedCap be used?

Wearable Devices

RedCap encompasses three key application categories: industrial wireless, video surveillance, and intelligent wearable devices. These applications prioritize stable, seamless data transmission rather than ultra-low latency. RedCap strikes a balance between enhanced Mobile Broadband (eMBB) and ultra Reliable Low Latency Communications (uRLLC), delivering optimal speed, energy efficiency, and cost performance.

VR Cinema



VR Cloud Gaming

AR Learning

Multiplayer VR Gaming

Cloud Assisted AR

Figure 4: RedCap covers a wide range of entertainment devices

Smart Grid

While RedCap's uplink speed may be lower than standard 5G, it meets the uplink requirements for 4K definition video, which cannot be fulfilled by either LTE Cat.4 or Cat.6. As a result, RedCap can be extensively used in applications like IPC (Internet Protocol Camera), UAV (Unmanned Aerial Vehicle) inspection, body-worn cameras, and 5G vehicles. In these scenarios, high-quality data uplink is the primary focus.

As a result, one notable application area for RedCap is the Smart Grid, where it can play a key role. With the low latency and high reliability of 5G, RedCap meets the safety and control requirements of the Smart Grid and significantly reduces the cost of 5G terminals. This makes it well-suited for applications such as inspection robots, drones, patrol cameras, and concentrators in power generation, transmission, and consumption scenarios.

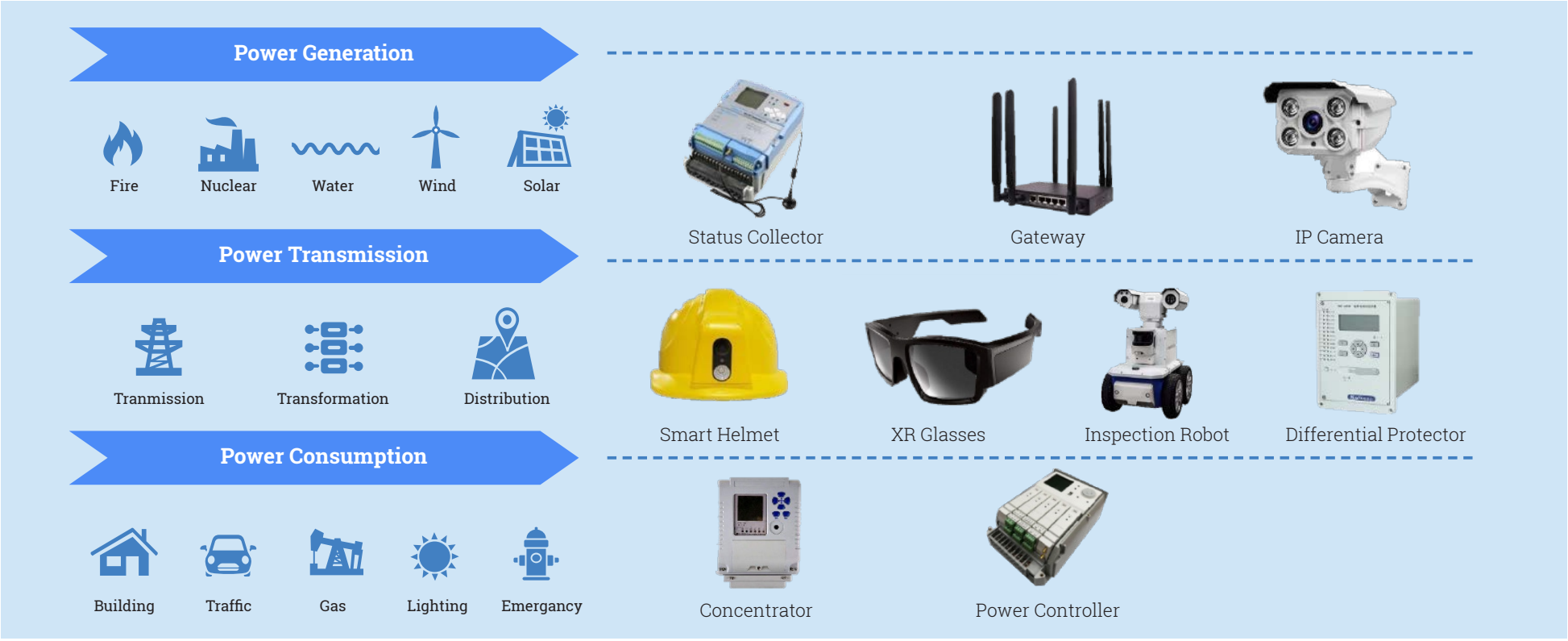


Figure 5: RedCap supports application across the smart grid

FWA (Fixed Wireless Access)

In 72% of countries globally, the average downlink experience speed for mobile users is below 50Mbps. Currently, 5G FWA products tend to be high-performance and high-priced, meaning there is a significant suppressed demand for entry-level market users. With a downlink peak of 223Mbps, RedCap presents a strong choice to meet the demands of this market segment.

5G Redcap is a strong contender as an ideal wireless solution for FWA device manufacturers such as mobile hot spot and PC to migrate 4G to 5G solutions. It offers an optimized 5G network experience and larger bandwidth capacity compared with the 4G solution.

Speedtest Global Index:

Statistics from July 2023 show the global average typical speeds for mobile users: DL (Downlink) 42.35Mbps / UL (Uplink) 10.04Mbps.

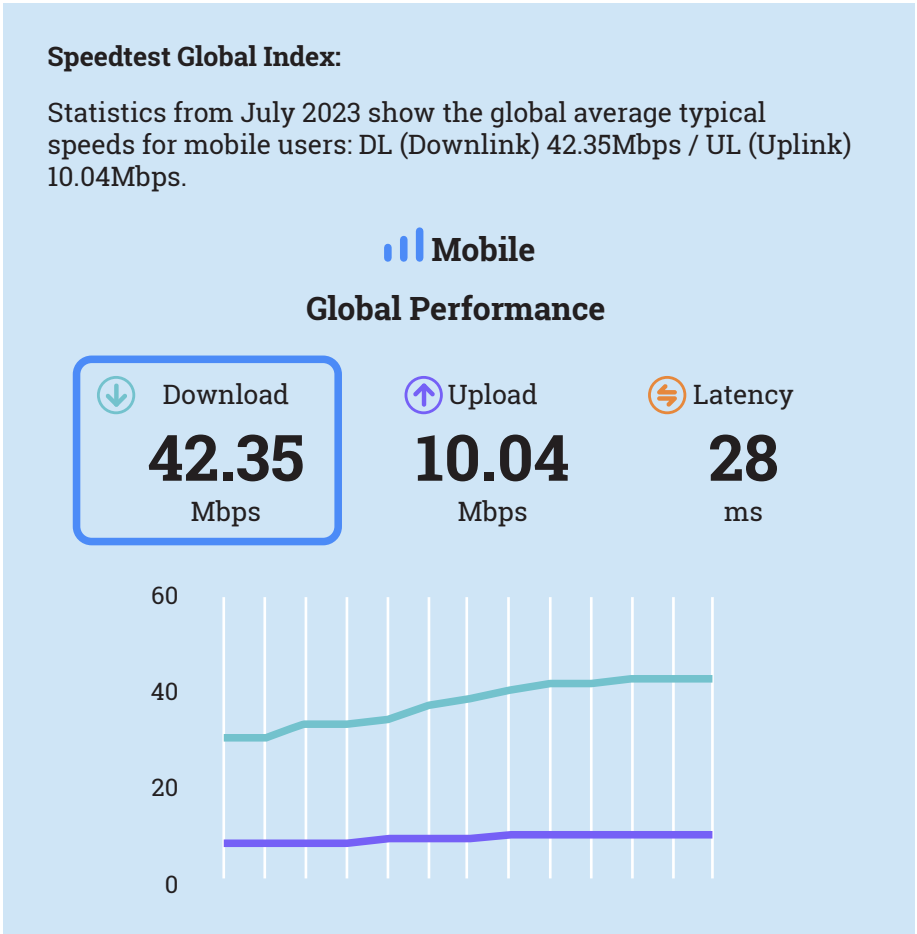


Figure 6: Downlink speeds for mobile users typically below 50Mbps

3. Fibocom recent announcements related to 5G RedCap

Fibocom Scales Up the 5G RedCap Module Series at MWC Shanghai 2023 with New FG131 Series Adding to the Portfolio

Fibocom showcases the new 5G RedCap modules portfolio including the new FG131 series and FG132 series at MWC Shanghai 2023. By addressing multiple key features of 5G RedCap, the FG131 module series allows the smooth and fast transition from 4G to 5G benefiting from the form factor design, and delivering a highly cost-effective solution for CPE, ODU, mobile hot-spot, USB Dongle users.

June 30th 2023 - Fibocom demonstrates the 5G RedCap module portfolio at MWC Shanghai 2023. Along with the FG132 module series, the brand new FG131 series is introduced to scale up the 5G NR light deployment for use cases such as CPE, ODU, mobile hot-spot, and USB Dongle, etc.

Leveraging ubiquitous cellular coverage, optimized power-saving, and reduced complexity, 5G RedCap is gaining more and more attention within the IoT industry. The newly launched Fibocom 5G RedCap module FG131 series offers a high-performance and ultra-reliable wireless solution for application scenarios that are cost-sensitive and power-enduring. Packaged in LGA form factor at the size of 37mm*39.5mm, Fibocom FG131 is pin-compatible with Fibocom LTE Cat 6 module FG101 and FG621 series that allows smooth migration from 4G to 5G RedCap. Compliant with 3GPP Release 17, it supports 5G SA and reaches peak rates of up to 226Mbps downlink and 120Mbps uplink theoretically. With these key features combined, the Fibocom 5G RedCap module FG131 series delivers a new level of 5G network experience while maintaining high reliability and cost-effectiveness, especially for terminal devices used in mobile scenarios.

Additionally, the Fibocom FG132 series has adjusted to three form factor designs and multiple regional versions that align with customers' requirements to accelerate the deployment of 5G RedCap worldwide. It is worth noting that these compact designs are pin-compatible with Fibocom LTE Cat 4 module NL668 and L716 series, and the dimension of FG132 (29mm*32mm in LGA form factor) account for only half the size of standard 5G module (41*44mm), significantly reducing the complexity of hardware design at the early stage of 5G RedCap adoption into terminals that shaped variously, for example, IP cameras, drones, wearable XR, etc. Moreover, the M.2 and miniPCIe form factors are the popular selections among manufacturing customers as both of them allow flexible connectivity ports while maintaining the compact size, thus making it easier for manufacturing customers to upgrade the existing LTE devices quickly without changing the hardware design. For example, industrial gateways, utility meters, etc.

Fibocom Introduces the FG132-NA RedCap Module Series towards Mid-tier 5G IoT Connectivity at Computex 2023

Fibocom introduces the 5G RedCap module series FG132-NA to its cellular product portfolio during Computex 2023.It is designed to offer downscaled connectivity service to mid-tier applications under the 5G landscape by bringing a realm of key advancements such as smaller compact size, optimized power efficiency and lower cost efficiency.

Taipei, Taiwan – May 30th 2023 - Fibocom announces the global launch of the new RedCap module series FG132-NA during Computex 2023. Compliant with 3GPP Release 17 standard, FG132-NA series adopt the key features from 5G in both network reliability and spectrum utilization, while significantly improving the performance in energy efficiency and expanding the diversity of IoT scenarios.

5G has achieved remarkable milestones in the past few years by accelerating the digital transformation of manufacturing, private networks, online education and more use cases with its ultra-fast speed, low latency and high reliability. As technology evolves, 5G RedCap is introduced to connect the "dots" in IoT under the 5G landscape, which of them are the scenarios that require ultra-low latency and high reliability, but less bandwidth and long battery life. Therefore, RedCap is the technology tailor-made for smart grids, livestreaming, industrial automation and smart wearables with its great performance in speed transmission and power efficiency, unleashing the full potential of 5G in IoT.

Fibocom FG132-NA series modules are compliant with 3GPP Release 17 standard, supporting 5G SA and are backward compatible with LTE Cat 4 networks. In terms of hardware architecture, the module series is adopting 1T2R antenna design along with LCC+LGA and M.2 form factors to satisfy the customers' expectations in a diverse of use scenarios. The size of LCC+LGA form factor can be measured at 29*32mm, which is pin-compatible with Fibocom LTE Cat 4 modules for customers to upgrade to 5G smoothly. While the plug-and-play M.2 form factor offers a comprehensive solution for tablets and industrial gateways with a compact size at 30*42mm. By leveraging the 5G key advancements, FG132-NA supports up to 220Mbps downlink speed and 100Mbps uplink speed, as well as 5G slicing, 5G LAN, assuring the speed performance and network reliability in the daily operation of manufacturing factory, IPC, smart grids, etc.

In addition to a set of innovations, Fibocom FG132-NA also supports Open CPU with OpenWRT software, which allows customers to develop FWA applications such as CPE, Mobile hotspot, and DTU flexibly.

4. Fibocom module range for 5G RedCap

Fibocom currently has two series of 5G RedCap modules – FG131 and FG132. Both of these are compliant with 3GPP Release 17 and both utilise the Qualcomm SDX35 modem.

The FG131 has the following main characteristics:

- **Target Terminals: IDU/ODU/Mobile hot-spot and other FWA devices**

- **Packaging and Pin Configuration:**
  - LGA form factor
  - Pin-to-Pin Cat.6 series
  - Enhanced compatibility with all Cat.4 pin functionalities (different size and position)
  - Expose chip platform capabilities valuable for FWA terminal forms, such as SGMII, etc.

- **Product Highlights**
  - Choosing Cat.6 packaging highlights FWA characteristics and value creation
  - Shared Wi-Fi solution with Cat.6, allowing mobile hot-spot customers to upgrade directly from 4G to 5G
  - FG131 enhances compatibility with all Cat.4 pin functionalities
  - Based on mature RedCap chip
    - SA 20MHz 256QAM: 220Mbps/120Mbps
    - LTE Cat.4+:195Mbps/75Mbps
  - Focus on FWA
  - Open CPU with OpenWRT
  - CPE/Mobile hot-spot:Wi-Fi 5 & Wi-Fi 6Solution
  - CPE/ODU:SGMII interface

- **Enhanced FWA Capability**
  - Higher Power Design for the Uplink
  - Supports SRS Functionality
  - RFFE Adopts Design with LNA
  - Expanded Flexibility

The FG132 has the following main characteristics:

- **Target Terminals:**
  - PC/Industrial Routers/Concentrators, etc.
  - Next-generation IoT applications under Cat.1, Cat.4, Cat.6

- **Packaging and Pin Configuration**:
  - 3 alternative form factors: LGA, M.2, MiniPCIe
  - Pin-to-Pin Cat.4 series (mainstream market packaging, pin compatibility with NL668/L716)

- **Product Highlights:**
  - Various solutions based on customer demand: Open CPU & MCU+Module
  - Support for SRS (Self-Refreshing Screen) technology
  - Low power consumption capability: APT (Advanced Power Management)
  - Based on mature RedCap chip
    - SA 20MHz 256QAM: 223Mbps/123Mbps
    - LTE Cat.4+:195Mbps/105Mbps
  - Wide Application Set
    - Replacement for Mainstream Size Cat.4
    - Rich Interface
    - Open CPU & MCU+Module Solutions
  - Highly Reliable Network Capability
    - Adaptation to Industrial IoT Protocols
    - Ensuring High-Definition Video Uplink Transmission
  - Low Power Consumption
    - Optimized Power Management
    - Support for APT (Advanced Power Management)

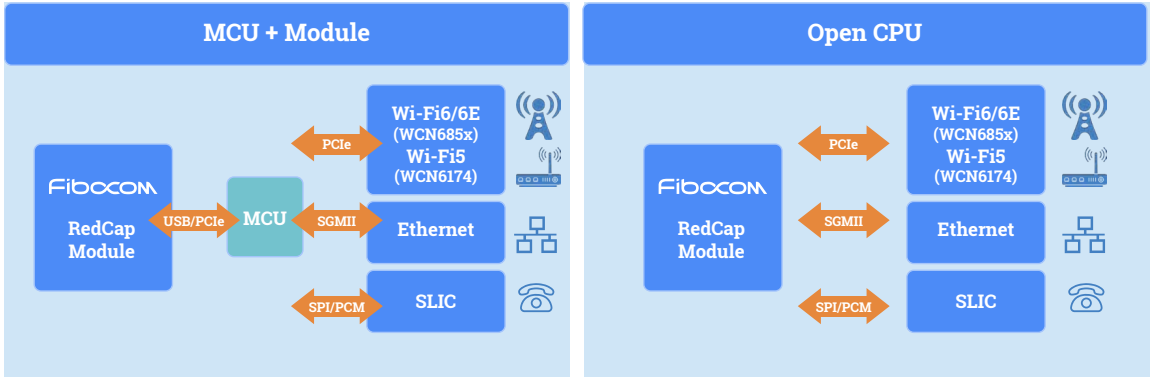


Figure 7: Application Architecture of Fibocom RedCap Modules

5. One-on-one interview with Fibocom

Robin Duke-Woolley
CEO
Beecham Research

Alex Zhu
Director of MTC Product Marketing Department
Fibocom

Robin Duke-Woolley (RDW), CEO of Beecham Research, interviewed Alex Zhu (AZ), Director of MTC Product Marketing Department at Fibocom, on how Fibocom is supporting the introduction of 5G RedCap in the market.

RDW: When do you expect RedCap R17 and then RedCap R18 to become significant in the IoT market?

AZ: As a relatively new technology, RedCap is still in its early stages of development, so technical market players such as the network operators, the chipset suppliers, module suppliers and terminal suppliers are still exploring this direction. As a result, the perspective we share here represents just the understanding of Fibocom with the hope it may provide insights for everyone.

We can evaluate the commercial development of RedCap based on the global rollout of 5G networks. The global development of 5G networks especially in the ongoing development of Standalone (SA) networks is the important element. NSA (Non-Standalone) is not sufficient as RedCap is a technology for SA networks. We anticipate RedCap in 3GPP Release17 (R17) will gradually start appearing in IoT terminals in small batches in 2024. Starting from 2025 the R17 version of RedCap is expected to enter a period of rapid development. As for 3GPP Release18 (R18), predicting timescales is quite challenging due to the technical standards not yet being finalised. We currently expect RedCap R18 IoT terminals to start coming to market in 2026.

RDW: How do you see them rolling out geographically?

AZ: The global development of 5G across regions is uneven. For RedCap it depends on the rollout of SA networks. We are initially focusing on China and US markets, All 3 main operators in China are actively supporting RedCap networks. Many Chinese cities already have SA base stations, so support for RedCap is expected to be widely available in 2024. Also in North America, we see that operators also have plans for promoting RedCap in 2024 – AT&T, T-Mobile and Verizon. Promotion in Europe is looking to be slower as their networks are mainly NSA at the moment. We are also looking closely at the Middle East and India markets. These markets also have SA networks.

RDW: Which LTE Categories with Redcap R17 and R18 replace?

AZ: RedCap R17 is expected to gradually replace LTE Cat 4 and Cat 6 products in the market. These will cover the various product forms for CPE, cameras, wearable devices, power equipment and in-vehicle smart devices. Some of these product markets have already transitioned to 5G from LTE but there remains a significant proportion that has not, mainly due to cost considerations. RedCap addresses this issue with its characteristics of low latency and high reliability. In the future, RedCap R18 version – also known as eRedCap or enhanced RedCap – will address a more extensive range of industry markets. Particularly those using LTE Cat 1 at present. Cat 1 is one of the fastest growing IoT product standards. It has very large volume in the China market. So RedCap R18 presents many significant opportunities for the next generation of devices.

We see that LTE networks are still great for many different parts of the market, for example Cat 1bis.

RDW: Do you see 4G LTE networks and 5G networks coexisting for some time?

AZ: Yes. We see LTE and 5G networks coexisting for a considerable time.

RDW: how will RedCap R17 and R18 compare in cost terms with current LTE Cats they are destined to replace?

AZ: This is an important point. Despite RedCap being positioned as the 5G solution for these 4G LTE Cats, the cost will initially be relatively high compared with those. At present, we see that the module cost of 5G RedCap R17 is at about double that for LTE Cat 4. However, as 5G RedCap products mature and the chipset and the module costs decline, this gap will narrow. The same trend is expected in the US. LTE products will not continue to be developed, whereas 5G products will be, so iteration of those products will bring them closer together in the future.

RDW: So when RedCap R17 comes to market, if it is considerably more expensive than LTE Cat 4 for example, why would people buy it?

AZ: we see our future customers buying the 5G RedCap R17 in 2024 or 2025, with a product that is much more expensive than Cat4 or Cat6 products, but these customers have said they need the 5G products because of their future plans. For 5G we have 5G LAN, low battery consumption and low latency promised by RedCap. It is not so much about the price for these customers.

RDW: When Redcap R18 comes, will that be more expensive that Cat 1?

AZ: Yes, it will still probably be more expensive than Cat1. But maybe the cost of R18 products will be more competitive than Cat 4.

RDW: Turning to Fibocom modules, there are two different ones launched so far – FG131 and FG132. What is the difference between them in terms of applications they serve?

AZ: These modules are designed for different markets. FG131 is primarily suitable for the FWA Fixed Wireless Access market, while the FG132 is intended for the general IoT market. The main distinction between the two is in the packaging size, with the FG131 inheriting more closely from the Fibocom Cat 6 product line, so pin compatible with our Cat 6 products. On the other hand, FG132 leans towards the Cat 4 product and is pin compatible with that. Of course there are also some differences in functions between these two. For example, the FG131 is more focused on the accelerated network usage. They have much higher speeds for gaming, for example.

RDW: What features like OpenCPU are included in RedCap modules?

AZ: we see that the features are very important for our industrial customers. So Fibocom RedCap products have numerous features – for example support of OpenCPU on both modules. This is particularly important for the FWA market and it has been widely adopted in numerous 5G FWA products. Additionally, RedCap products support GPS positioning functionality. Both these products support both of these features. However, it is worth noting that certain features like Bluetooth are not supported. But Fibocom will gradually enhance its products based on market demand to meet the needs of various customer applications.

RDW: are there any other features that they have, or are those the two main features?

AZ: We also have low power consumption features. FG132 has power save features eDRX, RRM relaxation and Envelope Tracking. This is more important in FG132 for IoT use, where customers are often using batteries. It is not so important for FG131 use in the FWA market.

RDW: Will iSIM be included in RedCap modules?

AZ: iSIM is not currently supported in FG131 or FG132. But we do provide support for eSIM. This allows our customers to have greater flexibility in different networks for a better experience. Of course, we do not rule out the possibilities of adding support for iSIM in the future.

FG131 and FG132 are available now for engineering samples for our customers and we have the LGA form factor for FG131. We have 3 form factor alternatives for the FG132 – LGA, M.2 and MiniPCIe. Both are for R17 and both are based on the Qualcomm SDX35 chipset. In the future with R18, we will evaluate other chipsets when they are available. iSIM is probably more relevant for R18 than R17 in fact. At present we don't see many requests for it so whether that is included in future or not is a decision that can be made later.

RedCap is still developing and the modules and technologies will evolve with more products available. My main focus now is on eRedCap (R18) – the next generation of RedCap. The requirement for this will be much greater than for today's RedCap R17.

6. Summary

5G RedCap, also known as New Radio lite (NR lite), provides an innovative solution to address the varying needs of different industries when adopting 5G technology. While primary use cases for 5G offer extensive capabilities, specific sectors require a more affordable and simplified alternative that still delivers essential 5G features.

RedCap also presents a significant commercial opportunity, particularly in the IoT market. Operators have well-defined plans for RedCap network iteration. RedCap can also be applied to vehicle terminals, industrial sensors, medical monitoring devices, and more. Overall, the future looks promising for RedCap.